Musculoskeletal disorders of the neck and shoulders in female sewing machine operators: prevalence, incidence, and prognosis

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Abstract

***Objectives*—To assess the occurrence and persistence of two restrictively defined neck-shoulder disorders among sewing machine operators. To assess factors associated with the development of neck-shoulder disorder and prognostic factors for remaining a case, when disorders were already present.**

***Methods*—In an initial group of 243 sewing machine operators, 178 were followed up for 2 years. At baseline and at 1 and 2 years follow up the participants underwent a clinical examination of the neck and arms and filled in a questionnaire about current musculoskeletal complaints. Clinical criteria for two main neck-shoulder disorders were defined: rotator cuff tendinitis and myofascial pain syndrome. A baseline control group consisted of 357 women with varied non-repetitive work.**

***Results*—At baseline the overall prevalence of myofascial pain syndrome and rotator cuff tendinitis was 15.2% and 5.8% among sewing machine operators compared with 9.0% and 2.2%, respectively, among controls. The presence of the disorders was strongly associated with a self perception of poor general health. Although myofascial pain syndrome showed a U shaped association with years as a sewing machine operator, rotator cuff tendinitis was absent among the newest recruits and present among 15% of the women with more than 20 years as a sewing machine operator. Besides years as a sewing machine operator, the risk of having a neck-shoulder disorder at baseline was significantly associated with high stress (prevalence ratio (PR)=2.54; 95% confidence interval (95% CI) 1.28 to 5.05) when adjusted for age, body mass index, smoking, living alone with children, job strain, and social support from colleagues and supervisors. Only one of 13 participants with rotator cuff tendinitis at baseline recovered during follow up. Myofascial pain syndrome showed a much more fluctuating tendency. Low social support (RR 3.72; 95% CI 1.22 to 11.30) and smoking (RR 3.93; 95% CI 1.33 to 11.58) were associated with the development of neck-shoulder disorders, which was also associated with neck-shoulder pain score and living alone with children.**

***Conclusion*—Rotator cuff tendinitis showed a higher degree of persistence than myofascial pain syndrome. Both disorders highly influenced the perception of general health. Women who lived alone with children, were smokers, or experienced low support from colleagues and supervisors had a higher risk of contracting a neck-shoulder disorder.**

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Keywords: rotator cuff syndrome; myofascial pain syndrome; follow up study; prognostic risk factors

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A high occurrence of musculoskeletal complaints and neck and shoulder disorders have been found in studies of women sewing machine operators,[1–10] and likewise among several other groups of women performing repetitive industrial work.[11–16] The job involves monotonous, highly repetitive tasks performed in a sitting working posture with upper back curved and head bent over the sewing machine. The work is visually demanding and requires a high degree of concentration and accuracy.

The prevalence of persistent neck and shoulder disorders has been found to increase with years of employment as a sewing machine operator.[17 18] However, some women never experience more than slight or moderate symptoms and never develop clinical neck or shoulder disorders despite many years of work. Knowledge of what makes neck and shoulder complaints develop into chronic conditions is sparse.

Most epidemiological studies of musculoskeletal complaints and clinically verified musculoskeletal disorders in the neck and shoulders have been cross sectional, thereby describing a mixture of acute and chronic disorders. A few case-control and follow up studies have reported aetiological risk factors[13 19 20] and prognostic risk factors.[21–23] In a review, Cole and Hudak[22] looked for evidence of prognosis among workers with non-specific work related musculoskeletal disorders of the neck and arms. Thirteen studies (1983–94) met the criteria to provide primary data based on clinical examination of workers who were followed up over time. The only repeated prognostic findings were duration of symptoms and undefined workplace demands. A 2 year follow up study,[21] including 96 women in the electronic manufacturing industry, showed that previous physically heavy work, high productivity, and previous sick leave were predictors of deterioration of symptoms from the cervicobrachial regions during the follow up period. An important predictor of improvement was reallocation to more varied work and physical activity in spare time.

This presentation is part of the Danish PRIM study (project on research and intervention in monotonous work) where 3123 participants were followed up for 3–4 years with the objective of examining physical and psychological effects of monotonous, repetitive work. The aim of the present study was to assess the occurrence and persistence of two restrictively defined neck-shoulder disorders among sewing machine operators, and to assess associated factors at baseline for becoming a case and prognostic factors for remaining a case, when disorders were already present. The overall objective was to obtain knowledge about prognosis that might contribute to future counselling of workers or patients with neck-shoulder disorders.

Materials and methods

DESIGN AND SAMPLING SCHEDULE

The study is a 2 year follow up study. At baseline and at 1 and 2 years follow up all participants filled in a questionnaire about current musculoskeletal complaints and underwent a standardised clinical examination of the neck and arms. During the years of the study (1994–7) a great part of the Danish textile industry closed down production in Denmark and moved to new plants in—for example, Poland. The present study was therefore affected with a relatively high drop out rate among a usually very stable group of employees (table 1). All the employees who dropped out were contacted and invited for examination at our clinic. Non-responders were contacted by telephone and interviewed about current health and reasons for leaving their job.

STUDY GROUP

The cohort was established in 1994–5 as a part of the Danish PRIM study. Two hundred and fifty nine women who were sewing machine operators from six departments in three different companies were invited to participate. Thus, no participants had pressing, cutting, or packing as their principal work at the time of the baseline examination. The women produced mainly children's wear, women's underwear, smocks, or coats. The main job was on line production with payment by the piece. Two hundred and forty three women agreed to participate (94%). At baseline the mean (SD) age was 38.3 (10.4) and duration of employment was 13.0 (9.6) years. Exclusion criteria were inflammatory rheumatic disease and disorders caused by trauma.

Table 1 Flow scheme of participation in the study

	n	*Drop out**	*Missing†*
Total study population	259		
Baseline questionnaire	239		
Symptom questionnaire:			
R1	241		
R2	163	27	51
R3	188	26	
Clinical examination:			
R1	243		
R2	158	57	28
R3	135	51	

*Drop out=subjects who left the study.
†Missing=subjects who were absent at R2 only.
R1=baseline; R2=1 year follow up; R3=2 years follow up.

Table 2 Flow of shoulder disorders (cases) during the three sampling rounds: baseline (R1), 1 year follow up (R2), and 2 years follow up (R3)

	R1	*R2*	*R3*	*n*
Remained case	C	C	C	6
	C	C	M	4
	C	M	C	6
				16
Case to non-case	C	C	NC	2
	C	NC	NC	4
	C	M	NC	3
	C	NC	M	3
				12
Remained non-case	NC	NC	NC	78
	NC	NC	M	38
	NC	M	NC	16
				132
Non-case to case	NC	NC	C	6
	NC	C	C	4
	NC	M	C	3
	NC	C	M	5
				18
Missing	C	M	M	12
	NC	M	M	48
				60

C=case; NC=non-case; M=missing.

One hundred and ten participants dropped out on either the questionnaire or the clinical examination during the 2 year period. The reasons given for dropping out were: 43 lost their job because of reduction in production, 22 had found another job, six had withdrawn from the study, 10 had left for reasons of health, and 29 had other or unknown reasons. To retain as many cases in the follow up analysis as possible, round 2 (R2) and round 3 (R3) were combined, and the changes between case or non-case are defined in table 2. Sixty women only participated in the baseline examination and therefore only contributed to the cross sectional analysis. The prevalence of neck-shoulder disorders in the drop out group was not different from the rest of the cohort (17.3% *v* 16.4%), but they were younger (mean (SD) age 35 (12), *v* 39 (10)) and had shorter dutation of employment (10 (11) *v* 14 (9) years).

CONTROL GROUP

The baseline control group consisted of 357 women with varied non-repetitive work. They came from 15 different industrial plants included in the PRIM health study. In the PRIM study, in each plant an ergonomist, a psychologist, and the local physicians had considered by observation and discussion with the workers and employers, which types of tasks should be considered non-repetitive job tasks suitable for inclusion of reference workers. The female control group consisted of workers with supervisory jobs, service jobs, office workers performing many different functions, and other workers considered to have a good deal of variation in their jobs. A total of 357 female workers were allocated to the control group and their baseline data was used for this study. The mean (SD) age of the control group was 38.2 (9.4).

QUESTIONNAIRES

On the day of each clinical examination all women returned a self administered questionnaire about current musculoskeletal

complaints. In the symptom questionnaire, which was a modified form of the method for grading severity of chronic pain developed by Von Korff *et al*,[24] the same set of four questions was asked for each of eight body regions: neck, low back, shoulders, elbows, and wrists and hands. The questions were answered by an indication on a 10 point scale ranging from 0 to 9. The questions combined intensity and limitation in daily activities over a 3 month period. The four questions asked were an indication of—for example, right shoulder—(*a*) worst trouble (pain or unpleasantness) in the past 3 months, (*b*) average trouble in the past 3 months, (*c*) interference in daily activities in the past 3 months caused by right shoulder trouble, and (*d*) trouble in the past 7 days. A sum score for each region could then be made by adding the scores from the four questions (score range: 0–36). When self reported complaints and objective clinical findings were combined to define a myofascial pain disorder in the neck-shoulder region, complaints from both neck and shoulder region were included. Experience has shown that complaints from the neck and shoulder regions are difficult to separate.[25]

All participants had returned a baseline questionnaire including questions on work exposure, health, personal factors, social relations, lifestyle, and physical activity in spare time. General health perception was assessed by a single item from the short form questionnaire 36 items health survey (SF-36)[26], which also applied to the present study with a single item on physical functioning (restricted in carrying groceries). The questionnaire included 23 items from the Karasek and Theorell job characteristic scale.[27] The answer to each item was dichotomised and given a raw score of 1 or 0 and three scales were constructed as raw score summations: job demand (0–3), job control (0–14), and social support (0–6). Subsequently a job strain score was constructed by multiplication of job demand and job control scores (range 0–42). An overall stress scale (range 0–27) was constructed by addition of 27 dichotomised items from the stress profile questionnaire by Setterlind and Larsson[28]: behavioural reactions (nine items), emotional reactions (eight items), cognitive reactions (four items), and psychosomatic symptoms (six items). For the multivariate regression models the job strain, social support, and stress scales were dichotomised.

CLINICAL EXAMINATION OF THE NECK AND SHOULDERS

All clinical examinations were done by trained physicians at the plant during working hours and the examiners were blinded to the answers from the questionnaire. Neck and shoulder examinations were focused on palpation tenderness, clinical tests, and range of motion of the shoulders. Palpation was carried out with an intended 4 kg pressure with a flat thumb perpendicularly on the surface of the four muscles: neck joint, trapezius border, supraspinatus, and infraspinatus. Palpation was not made over the muscle to find tender points. Palpation tenderness was graded on a 0–3 scale where 0 was no tenderness, 1 was slight tenderness but no avoiding reaction, 2 was moderate tenderness and avoiding reaction, and 3 was pronounced tenderness with flick or withdrawal; neck-shoulder palpation score range: 0–24. The tuberculum major was palpated at the insertion of the supraspinatus muscle. Isometric shoulder strength measurements were performed by lifting with the arm stretched and horizontal in the plane of scapula. The mean value for the best of three lifts on each shoulder side was noted. The tests were performed by an Isobex 2.1 microprocessor (ISOBAR, Crumbed ERG, Bern, Switzerland). Scores were given for range of motions in the shoulder joint according to flexion, abduction, and functional internal and external rotation. Finally the shoulder was tested for impingement pain and pain on resisted abduction. No diagnoses were made during examination. Information about years of employment as a sewing machine operator was obtained by interview at the time of the first clinical examination.

DIAGNOSTIC CRITERIA

The heterogeneity of neck-shoulder disorders makes case definition a challenge. Definitions and diagnostic criteria used in earlier research are numerous and the naming of the disorders are no less chaotic. Another critical question is the extent to which self reported complaints correspond to clinically verified disorders. Criteria for the present diagnoses were made at the beginning of the study and did not differ much from the latest published proposal for consensus on upper limb pains.[29] Our criteria for neck-shoulder diagnoses included self reported pain as well as objective clinical findings.

Rotator cuff tendinitis

- Self reported pain in the shoulder region (sum score maximum 12 in relevant shoulder region)
- Palpation tenderness at the tuberculum majus humeri or sign of subacromial impingement
- Shoulder pain on resisted abduction.

Myofascial pain syndrome

- Pain in the shoulder, or neck region, or both (sumscore maximum 12 in neck and/or relevant shoulder region)
- Palpation tenderness graded 2 or 3 (0–3 scale) in a minimum of one of the upper neck muscles and upper trapezius muscle; and in a minimum of one of the supraspinatus and infraspinatus muscle in the relevant neck-shoulder region.

Neck-shoulder disorder refers to a subject having either one or both of the two defined disorders.

ANALYSIS

In the cross sectional analysis a Cox's proportional hazards model was applied with a constant follow up time (time of baseline examination) to estimate prevalence ratios for a set of independent predicting variables for the presence or absence of a neck-shoulder

Table 3 Baseline distribution of neck-shoulder complaints and clinically verified shoulder disorders in four seniority groups of sewing machine operators

	Duration of exposure as a sewing machine operator(y)			
	≤2 (n=32)	*2–10 (n=80)*	*10–20 (n=67)*	*>20 (n=59)*
Neck-shoulder complaints (%):†				
None	22	29	24	12
Light	50	49	42	40
Moderate or severe	28	22	34	48
Subjects with verified shoulder disorder (%):				
Myofascial pain syndrome	19	7	10	31
Rotator cuff tendinitis***	0	1	6	15

***p<0.001, χ^2 test for linear trend=12.85, df=1,
†None=neck-shoulder pain score 0, light=neck-shoulder pain score 1–24, moderate or severe=neck-shoulder pain score ≥24.

disorder. Introduction of interaction terms between age and duration of employment and between job strain and stress in the baseline regression model did not contribute significantly to the model.

One way analysis of variance (ANOVA) was applied to test the hypotheses of equal means, and frequency distributions were compared with the χ^2 test. A combination of few cases and a high drop out rate made follow up analyses over three rounds meaningless. Rounds two (R2) and three (R3) were combined, so the change between case and non-case was analysed as a change between round 1 (baseline) and R2 or R3 as illustrated in table 2.

We used Cox's proportional hazard analysis to estimate relative risks (RRs) adjusted for multiple potential confounders. Significance was defined as p<0.05. All statistical analyses were performed with the SPSS statistical package.

Results

Baseline scores of neck-shoulder complaints and results from the clinical examination of 243 women sewing machine operators are presented in table 3. Because of missing questionnaire data for five women, a baseline diagnosis of neck-shoulder disorder could be given to only 238 participants. The baseline prevalence of myofascial pain syndrome among sewing machine operators was 15.2% and 9.0% in the control group (prevalence proportion ratio (PPR)=1.7; 95% confidence interval (95% CI) 1.1 to 2.6); 5.8% of the sewing machine operators and 2.2% of the controls had a verified rotator cuff tendinitis (PPR= 2.26; 95% CI 1.1 to 5.9).

Among sewing machine operators the prevalence of rotator cuff tendinitis increased by duration of employment, whereas myofascial pain syndrome showed a U shaped trend with the highest frequencies with the shortest and longest durations of employment. This U trend corresponded to the distribution of moderate to severe neck-shoulder complaints in the four groups of duration of employment. Among all participants with moderate to severe neck-shoulder complaints in the screening questionnaire, 62.8% also reported having had neck, or shoulder problems, or both for more than 3 months within the past year. This percentage was 14.6% for participants with minor complaints and 2.0% (one person) for women with no complaints. This aspect of chronicity was independent of duration of employment.

The occurrence of sickness absence was limited in this working group. Among all participants, 17.8% reported having had at least 1 day absent within the past year because of musculoskeletal problems including neck, shoulder, arms, hands, and back. Of these, neck-shoulder problems were the most common cause of sickness absence. Having had at least 1 day absent due to neck-shoulder problems within the past year was reported by 11.9%, whereas having had 8 days or more absent was reported by 4,7%.

Table 4 shows the association between neck-shoulder disorders at baseline and several potential explanatory variables or confounders. There is an exposure-response relation between neck-shoulder disorders and years as a sewing machine operator, still with the exception of a high prevalence among the newest recruits. When the same analysis was done with the study group divided into two age groups (younger or older than 40 years), the same association was found. This indicated no healthy worker selection, as earlier illustrated in the fish processing industry.[30] In the full baseline model, stress was significantly associated with having a neck-shoulder disorder. To assess the influence of the neck-shoulder disorders on daily living, examples are given in table 5, in which measured isometric shoulder strength, and an item of physical functioning and general health are given for cases and non-cases. More than 50% of the participants with a neck-shoulder disorder described some degree of restriction in lifting or carrying daily groceries and 43% had estimated their general health as fair or poor.

The progress of neck-shoulder complaints for all sewing machine operators is illustrated

Table 4 Bivariate and multivariate prevalence ratios (PRs (95% CIs)) for the risk of having a neck-shoulder disorder at baseline

		Risk of having a shoulder disorder			
		Bivariate		*Multivariate**	
	Subjects (n)	*PR*	*95% CI*	*PR*	*95% CI*
Duration of exposure (y):					
≤2	34	2.50	0.81 to 7.75	2.44	0.72 to 8.23
2–10	83	1.00		1.00	
10–20	67	1.79	0.64 to 5.03	1.80	0.62 to 5.26
>20	59	4.29	1.71 to 10.75	4.44	1.54 to 12.78
Age (y):					
≤40	141	1.00		1.00	
>40	102	1.66	0.89 to 3.09	0.86	0.37 to 2.03
Smoking:					
No	126	1.00		1.00	
Yes	112	1.55	0.83 to 2.90	1.62	0.83 to 3.13
Body mass index:					
<20	37	0.86	0.35 to 2.13	0.72	0.26 to 1.83
20–25	117	1.00		1.00	
>25	85	0.74	0.37 to 1.50	0.71	0.34 to 1.47
Living alone with children:					
No	227	1.00		1.00	
Yes	16	1.78	0.63 to 4.99	1.35	0.37 to 4.95
Job strain:					
Low	144	1.00		1.00	
High	95	1.11	0.59 to 2.08	0.88	0.45 to 1.71
Social support:					
High	155	1.00		1.00	
Low	83	1.59	0.85 to 2.98	1.66	0.86 to 3.23
Stress:					
Low	155	1.00		1.00	
High	83	2.89	1.53 to 5.44	2.54	1.28 to 5.05

*Multivariate=all independent variables from this column are entered into the Cox's proportional hazards model.

Table 5 Mean isometric shoulder strength by the status of disorder on right and left shoulder compared with a group with no disorder on either side (distribution of the answers to single items on physical functioning and general health)

	No disorder			*Disorder*			
	n	*Mean*	*SD*	*n*	*Mean*	*SD*	*p Value*
Isometric shoulder strength (kg):							
Right	197	5.7	1.4	26	4.2	1.6	<0.001
Left	197	5.5	1.2	32	3.9	1.5	<0.001
	No disorder			Disorder			
Restricted in carrying groceries (%):							
No	82			49			
Yes, little	17			35			<0.001
Yes, much	1			16			
Percieved general health (%):							
Excellent or very good	38			17			
Good	51			40			<0.001
Fair or poor	11			43			

in table 5. To assess prognostic factors for continuing to have a neck-shoulder disorder, we compared the two groups where all had been cases (n=28) at baseline. In R2 or R3 16 remained cases and 12 became non-cases. Among the 28 participants who were cases at baseline, 13 had a rotator cuff tendinitis and 15 had myofascial pain syndrome as the only disorder. Only one of the 13 participants with rotator cuff tendinitis experienced improvement sufficient to become a non-case. Eleven of the 15 subjects with myofascial pain syndrome became non-cases at follow up. We found no indication of physical training in spare time being related to improvement of neck-shoulder disorders as was reported earlier.[12] Having left the job as a sewing machine operator at the time of follow up was not associated to the presence of disorder (six of the 16 who remained cases had left the job, four of the 12 who became non-cases had left the job).

To assess factors associated with becoming a case, the two groups where all had been non-cases at baseline were compared. In R2 or R3 132 stayed non-cases and 18 became cases. In a Cox's regression model (table 6) low social support from colleagues and supervisors at the time of baseline was significantly associated with becoming a case during follow up.

Discussion

The cross sectional part of this study (n=238) showed a U shaped association between years as a sewing machine operator and myofascial pain syndrome, whereas the association between duration of employment and rotator cuff tendinitis showed a positive linear trend. The follow up part of the study showed rotator cuff tendinitis to be a very persistent disorder. The development of a neck-shoulder disorder during a 2 year period was significantly associated with reporting low social support. In this study R2 and R3 were put together in the analyses and incidences could therefore not be measured as the time of incidence was unknown. Alternatively we could have measured an incidence proportion as the risk of developing a neck-shoulder disorder within the period of 2 years.

With a high participation rate of 94%, there should be no problems of selection of special groups from the employees into the study. The follow up part was impaired by a high drop out rate resulting from reduced production and redundancy in the textile industry in this period. However, the prevalence of neck-shoulder disorders in the drop out group did not differ from the remaining group, giving us no reason to think that it would influence the risk estimates.

It is well known that the presence and intensity of musculoskeletal disorders in the neck and shoulder fluctuate. And it is known, that the prevalence of self reported complaints within 12 months, 3 months, or only 1 week are very high even among the general population. As we wanted to examine the persistence of neck-shoulder disorders, which could be of importance to daily activities and work, we had to make clear and rather restrictive diagnostic criteria to separate them from more diffuse conditions. Thus, the prevalence of the particular neck-shoulder disorders in this study were lower than the range of earlier studies[7 9] but compared with women with varied non-repetitive work in the control group the prevalence of shoulder tendinitis and myofascial pain syndrome was significantly higher. In the comparison group from the PRIM study cohort the same diagnostic criteria were applied and the clinical examinations were partly done by the same examiners. The significantly lower shoulder strength among the sewing machine operators with neck-shoulder disorders and the reporting of widespread restriction in a simple activity such as lifting or carrying daily groceries gave us an additional aspect of the consequences of these disorders.

Table 6 Unadjusted and adjusted rate ratios (RRs) for developing a shoulder disorder in R2 or R3, for those without a shoulder disorder at baseline

		Unadjusted			*Adjusted**		
Factors	*Subjects*	*RR*	*95% CI*	*p Value*	*RR*	*95% CI*	*p Value*
Social support:							
High	104	1.00			1.00		
Low	45	3.30	1.26 to 8.67	0.02	3.72	1.22 to 11.30	0.02
Neck-shoulder pain score†	150	1.02	0.99 to 1.04	0.18	1.02	1.00 to 1.05	0.19
Smoking:							
No	81	1.00			1.00		
Yes	68	2.18	0.81 to 5.91	0.12	3.93	1.33 to 11.58	0.01
Living alone with children:							
No	141	1.00			1.00		
Yes	9	3.30	1.26 to 8.67	0.02	3.58	0.87 to 14.68	0.08

*Adjusted for age, job strain, stress, and duration of employment.
†Neck-shoulder pain score is included in the model as a continuous covariate.

Also, both disorders highly influenced the perception of general health. The perception of fair or poor general health could be interpreted as a consequence of neck-shoulder disorders because of the relation between them in the cross sectional analysis, but not to development of disorder in the follow up analysis.

To heighten reproducibility between examiners and minimise misclassification of clinical signs the examiners were trained at several sessions before the onset of the study. Reports on reliability will be given separately in a forthcoming paper. Anyway, misclassifications are inevitable, but in this study they were probably non-differential as the examinations were made without knowledge of the potential risk factors that were chosen for assessment. Recently Harrington *et al*[29] published the results of a consensus conference on case definitions for several common work related arm pain syndromes. On shoulder tendinitis, points of discussion were, whether this condition should be seen as a single diagnosis or identified as four separate case definitions based on the tendon affected. The consensus concluded, as we have done, that the rotator cuff syndrome is a condition where differentiation between different parts of the cuff is neither reliable nor clinically relevant. At follow up, the examiners were not aware of the previous state of disorder.

The diagnosis of rotator cuff tendinitis seemed to be a very strong predictor of having a chronic shoulder disorder, as only one of 13 participants with rotator cuff tendinitis at baseline recovered during follow up. This is a low recovery compared with the report by Hagberg,[31] where eight out of 20 patients in a study of assembly workers with chronic shoulder tendinitis recovered during a 2 year follow up. This aspect of chronicity, combined with a disability often associated with pain and estimation of general health as fair or poor, ought to make us more alert to preventive measures against this disorder. Compared with rotator cuff tendinitis, myofascial pain syndrome was a much more fluctuating disorder. This is clinically well known but could reflect the nature of the disorder as well as the problem of diagnosis.[32] The findings of this study support a hypothesis: myofascial pain problems are frequent in the beginning of the employment period as a sewing machine operator, then decrease in prevalence and progressively return with duration of employment together with an increase in cases of rotator cuff tendinitis, when employment has exceeded 10 years. This exposure-response for neck-shoulder disorders among sewing machine operators has been described earlier by Andersen *et al*,[17] where being a sewing machine operator for more than 8 years was found to have a cumulative permanent harmful effect on the neck and shoulder region. Ohlsson *et al*[30] also found a pronounced exposure-response relation for disorders of the neck and shoulders with duration of exposure in the fish processing industry but only in the group of women below 45 years of age. This pattern was discussed and explained by the healthy worker effect. In the present study, we found no sign of a healthy worker selection. This corresponds with our general impression from several visits to the plants and through conversations in connection with the examinations. It seems that despite this high prevalence of severe neck-shoulder complaints and sometimes even difficulties in lifting the arms, the sewing machine operators try to organise themselves to keep up with daily work. This is reflected by a very low occurrence of sickness absence in this group.

Earlier studies of psychosocial factors, reviewed by Bongers *et al*,[33] suggest that lack of social support from colleagues is positively associated with musculoskeletal symptoms, and that stress perhaps is an intermediary state in the process. This is supported by the present study, where having a neck-shoulder disorder in the cross sectional analysis was associated with low social support and significantly associated with a high level of stress. In the follow up analysis low social support but not stress remained associated with the development of a neck-shoulder disorder, indicating the presence of stress as neck-shoulder problems develop. The association between low social support and newly developed musculoskeletal disorders is hypothetical, but could perhaps express a lack of opportunity for individual organisation of daily routines and taking breaks when needed.

We know that conditions that are found to be related to disorders may be a result of the disorder rather than a cause, when disorders are present at the outset. Therefore, follow up studies are essential for an assessment of aetiological risk factors. When studying prognostic factors the order of effects are of no importance but of course the follow up design is evident. In this study, the crucial factor for a poor prognosis was having a rotator cuff tendinitis. Smoking turned out to be associated with the development of neck-shoulder disorders. We have no explanation for this finding, which is in line with previous research[34 35] but considerations might be that smoking is associated with other undefined social or work related cultural factors of importance. Earlier studies[6 13 17] have evaluated the relation between presence of neck-shoulder complaints and having preschool children, and the results have been divergent. In this study, we found that living alone with children was associated to the development of a neck-shoulder disorder. This might have a plausible explanation in the lack of restitution when coming home from work. However, all associations should be interpreted with great cause as the number of cases were few.

The objectives of this study have concentrated on prevalence, incidence, and prognosis of two neck-shoulder disorders among a working group with a homogeneous exposure. The subjects who changed between case and non-case during the follow up period came from all of the three different companies and the exposure had not obviously changed over time. Ergonomic exposure measurements from the PRIM study will be reported elsewhere. The study supports the multifactorial nature of both aetiology and prognosis of these disorders.

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